OTT Analytic Program Review

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Definition of Terms Describing Quantities of Fossil Fuels

The level of any type of fuel quantity is always in a state of flux as the level of consumption, ability to measure, and economic feasibility of recovery change

① "Reserves" = Quantities that have been measured in known reservoirs and can be extracted economically

② "Resources" = Quantities that have not been measured with the same level of accuracy of reserves and may not be economically recoverable with today's level of technology and fuel prices

③ "Additional Occurrences" = Quantities that have unknown degrees of assurance and with unknown or speculative economic significance

Remaining Fossil Fuel Quantities (Billions of Barrels of Oil Equivalent)

Fossil Resource	Reserves	Resources	Additional Occurrences	Total
Oil				
Conventional	1,100	1,063		2,163
Unconventional	1,340	2,460	13,370	17,170
Natural Gas				
Conventional	1,030	2,050		3,080
Unconventional	1,410	1,890	2,840	6,140
Hydrates			137,500	137,500
Coal	7,350	17,570	20,860	45,780
Total	12,230	25,033	174,570	211,833

Source: H-H. Rogner, "An Assessment of World Hydrocarbon Resources," Annual Review of Energy and Environment, 1998.

Note: World oil use in 1996 is 26 billion barrels and is projected to grow to 42 billion barrels in 2020.

Estimates of Remaining Oil Resources(Billion Barrels of Oil)

Campbell & Laherrere (Scientific American)	1000
Hatfield (Univ. of Toledo)	1550
USGS (Draft OTT Fuels Database)	1684
Edwards (Univ. of Colorado)	2036
IIASA	2163
Energy Modeling Forum 14	2330

Potential Renewable Resource Availability (Billion Barrels of Oil Equivalent per Year)

Resource	U.S./ North America	World	Comments
Hydropower	2	11	Technical potential
Wind	3	31	Class 3+; land restrictions
Solar	16	68	Accessible w/ today's tech.
Geothermal	---	81	Available in next two decades
Biomass	7	48	Potential supplies
Ocean	---	29	Technical potential

Source: Calculated from data in "Renewable Energy: Sources for Fuels and Electricity," Laurie Burnham, ed. (Island Press: Washington, D.C., 1993).

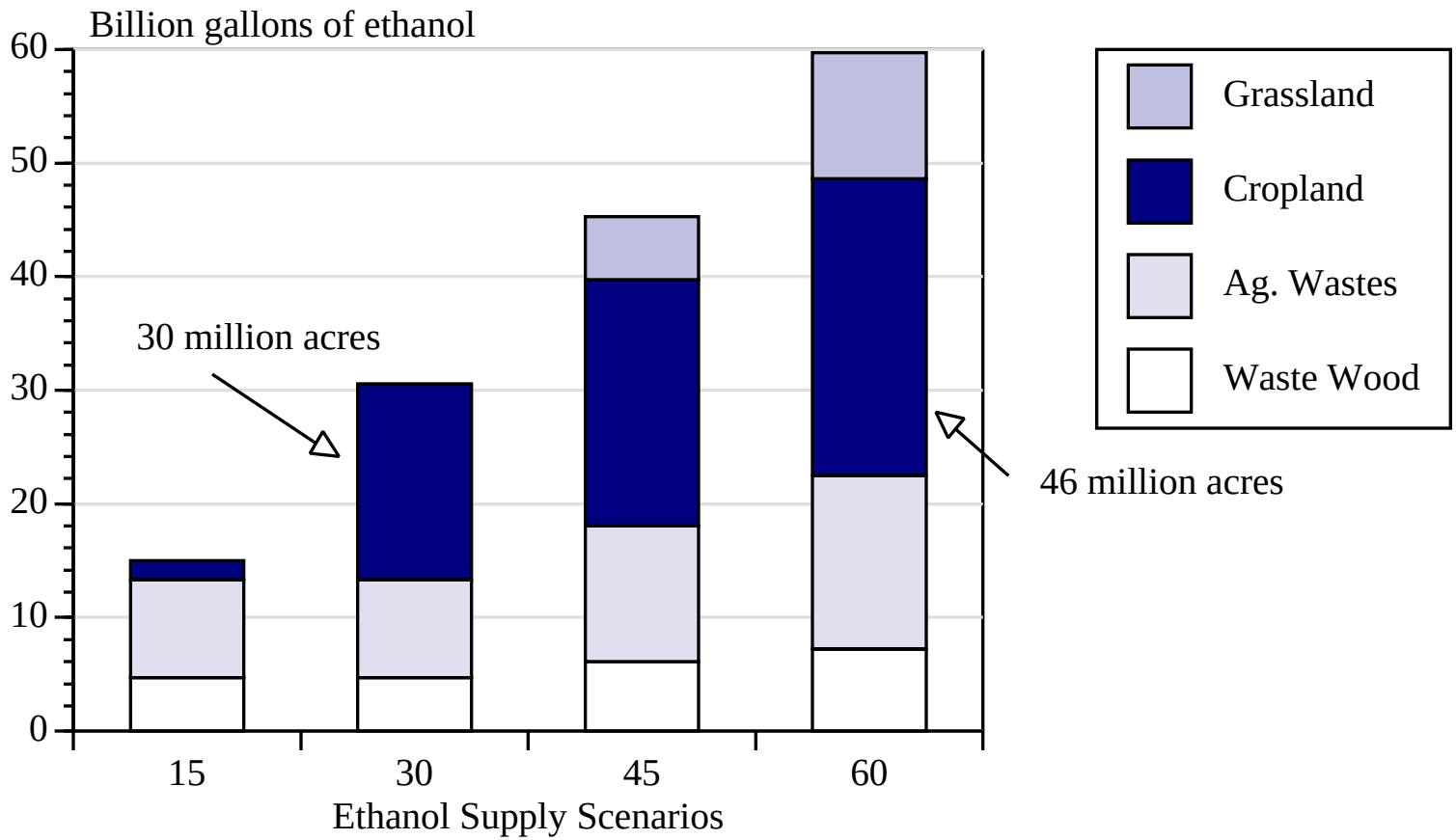
Note: For comparison, in 1997, the U.S. consumed about 16 billion barrels of oil equivalent (6.2 billion barrels of oil).

Ethanol Supply Scenarios

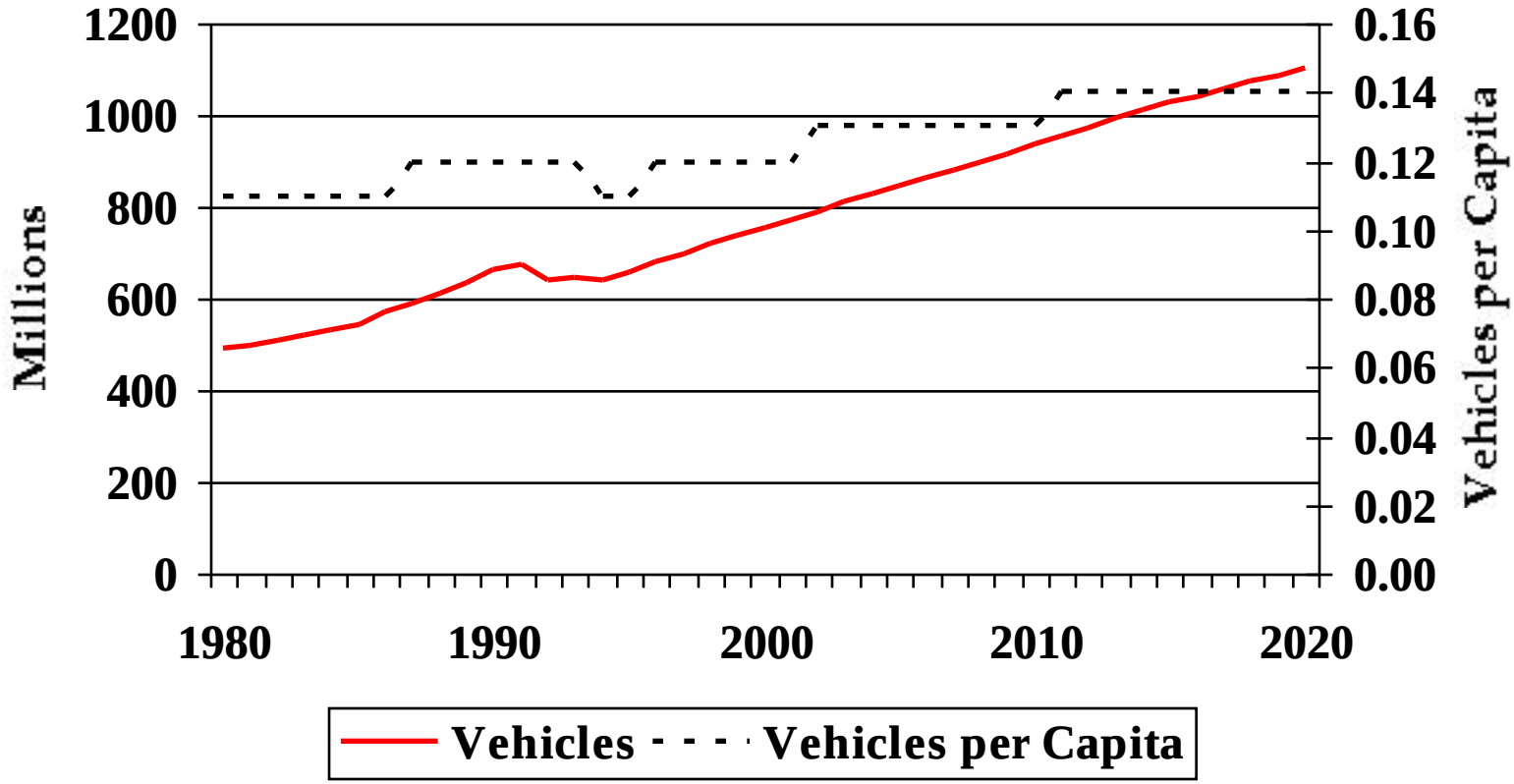
Ethanol (billion gallons)	15 (9.6)	30 (19.2)	45 (28.8)	60 (38.4)
Waste Wood (millions tons)	50	50	63	75
Ag. Wastes (million tons)	90	90	125	160
Cropland (million acres)	3	30	38	46
Grassland/ Rangeland (million acres)	0	0	30	59
Total Tonnage (million tons)	158	320	475	630
Carbon Reduction (MMTC)	21.4	42.8	64.2	85.6

Assumptions: Cropland yield = 6 tons per acre; grassland yield = 2 tons per acre; ethanol conversion efficiency = 95 gallons per ton. There is 460 million acres of cropland and 589 million acres of grassland in the US.

Ethanol Supply Scenarios

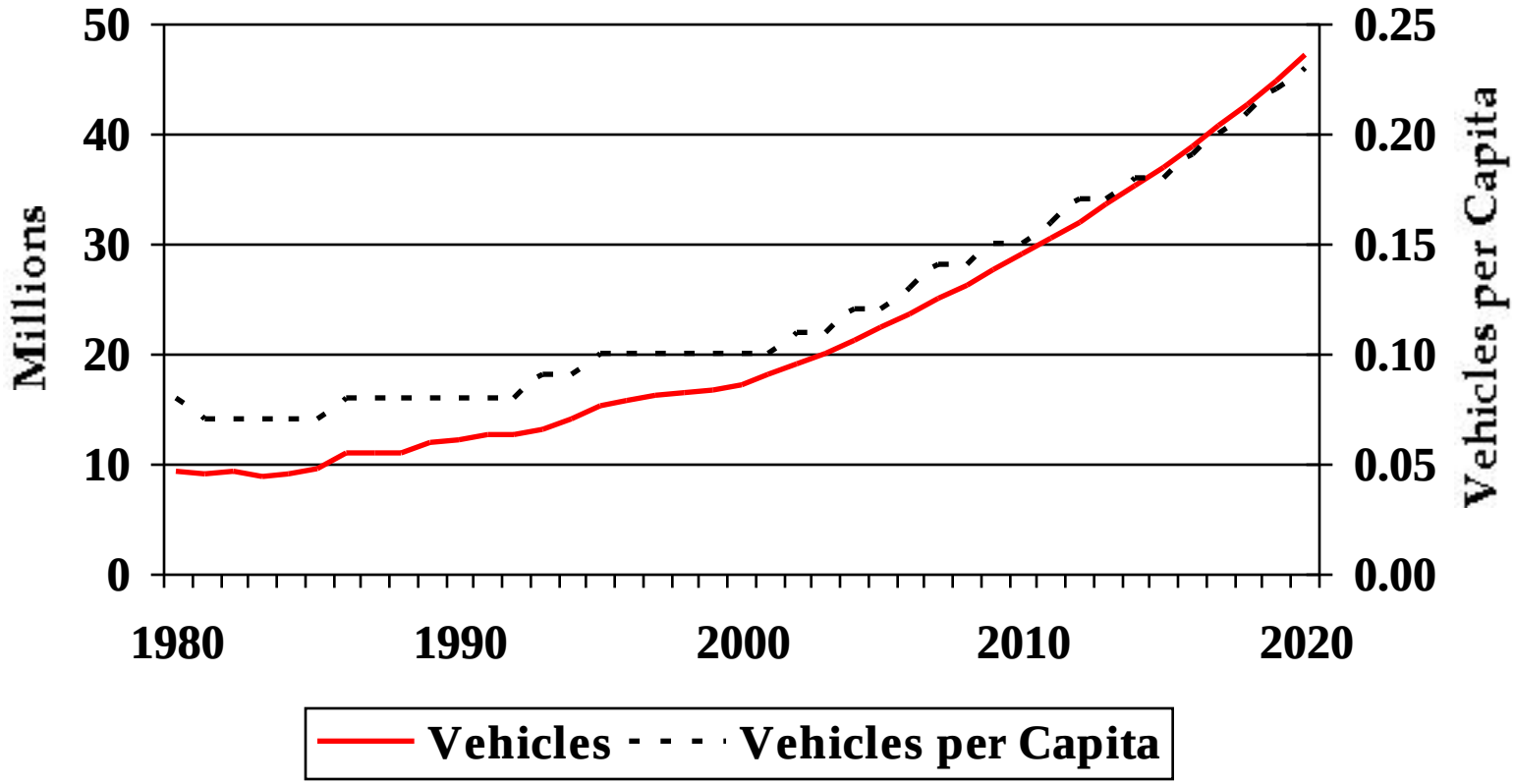


Projected World Vehicle Ownership



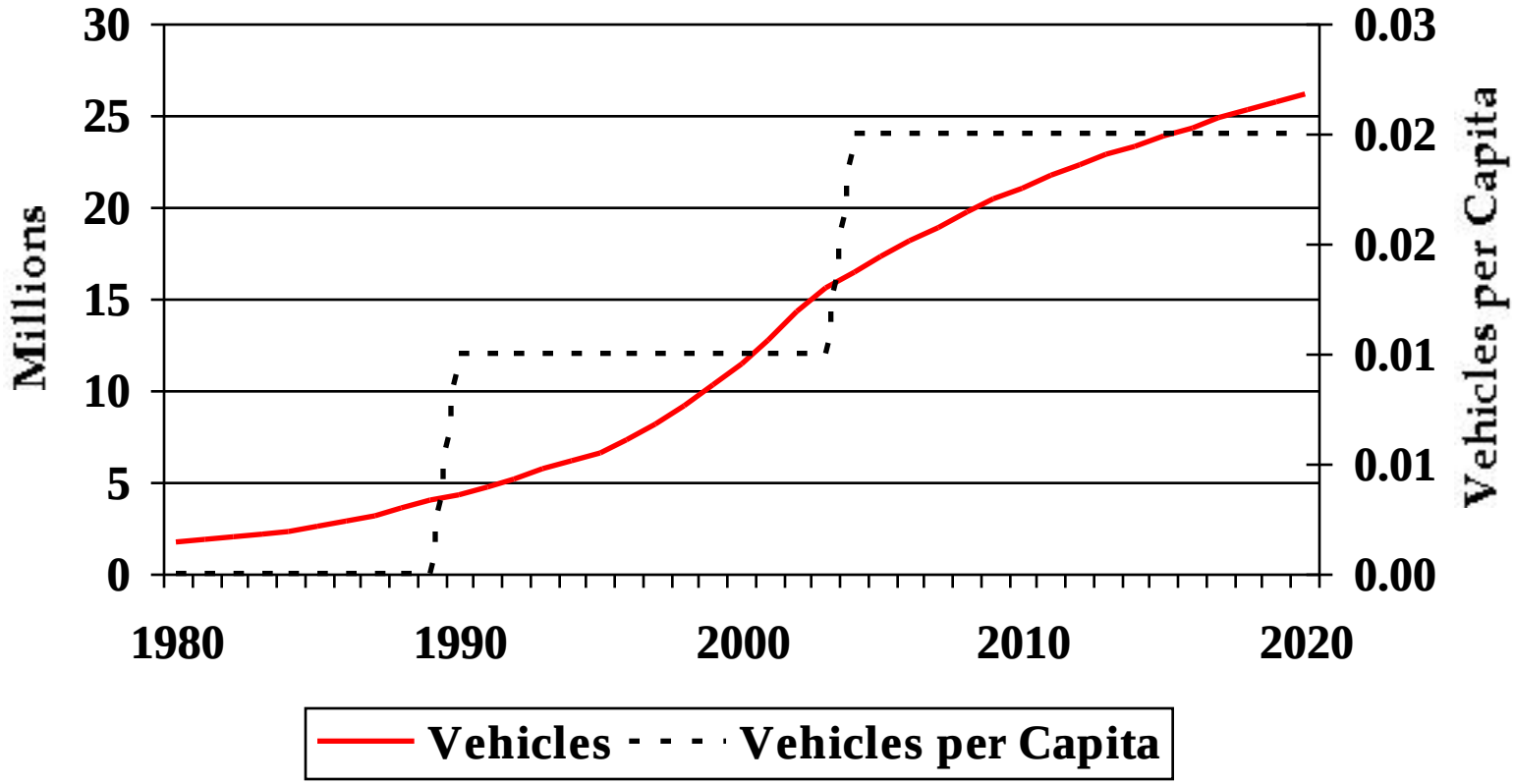
Source: WEPS2000

Projected Vehicle Ownership for Brazil



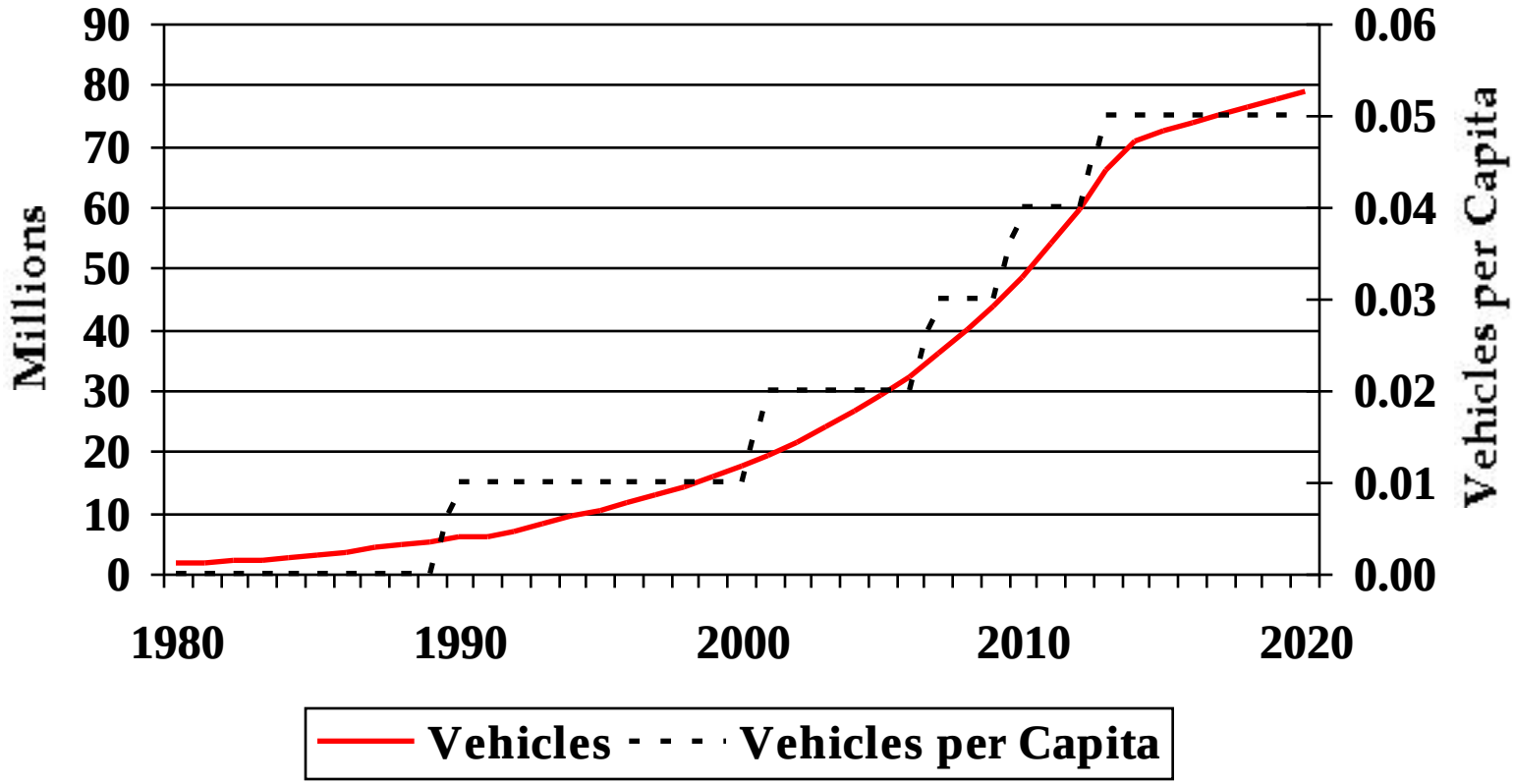
Source: WEPS2000

Projected Vehicle Ownership for India



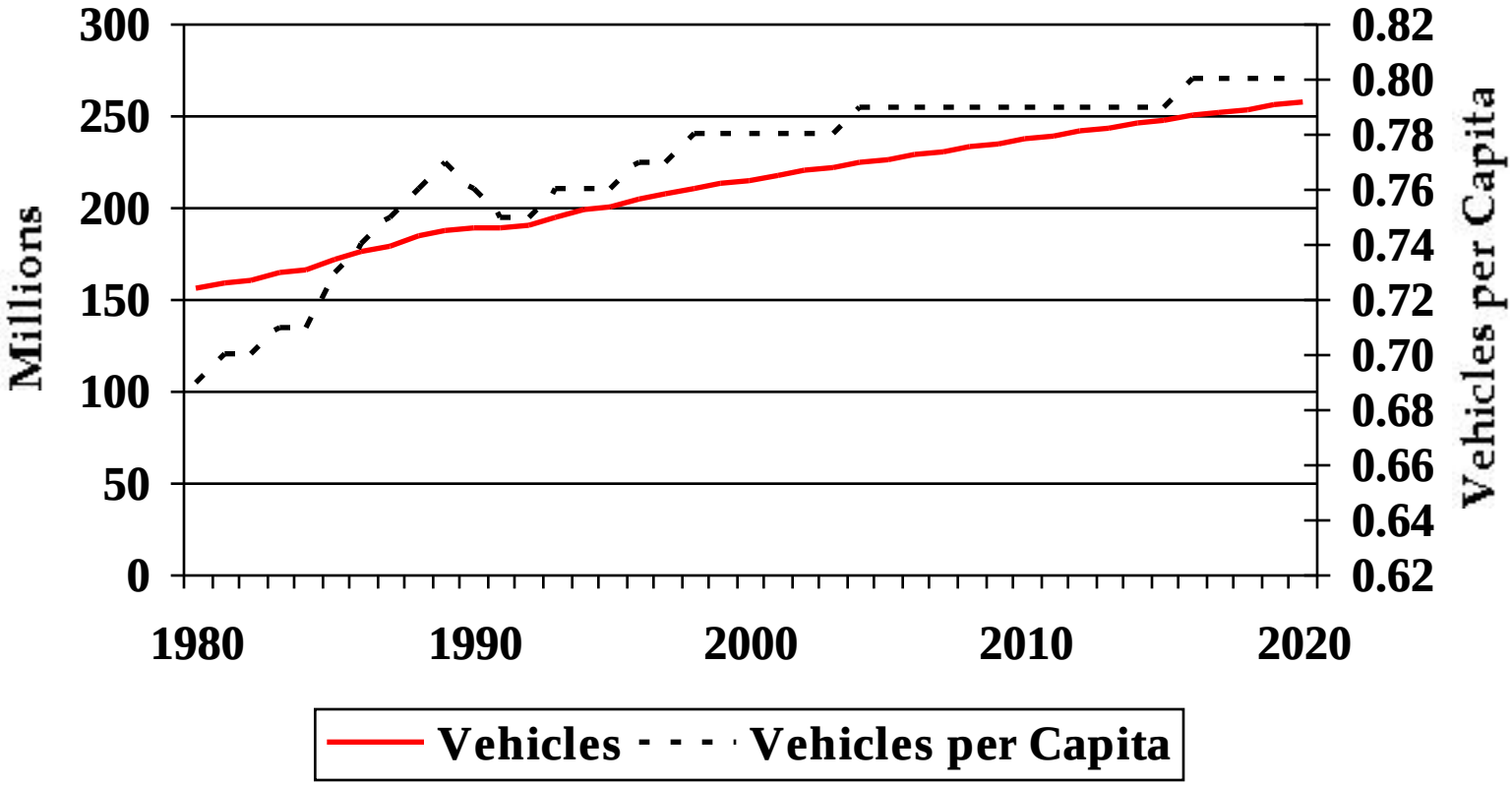
Source: WEPS2000

Projected Vehicle Ownership for China



Source: WEPS2000

Projected U.S. Vehicle Ownership



Source: WEPS2000

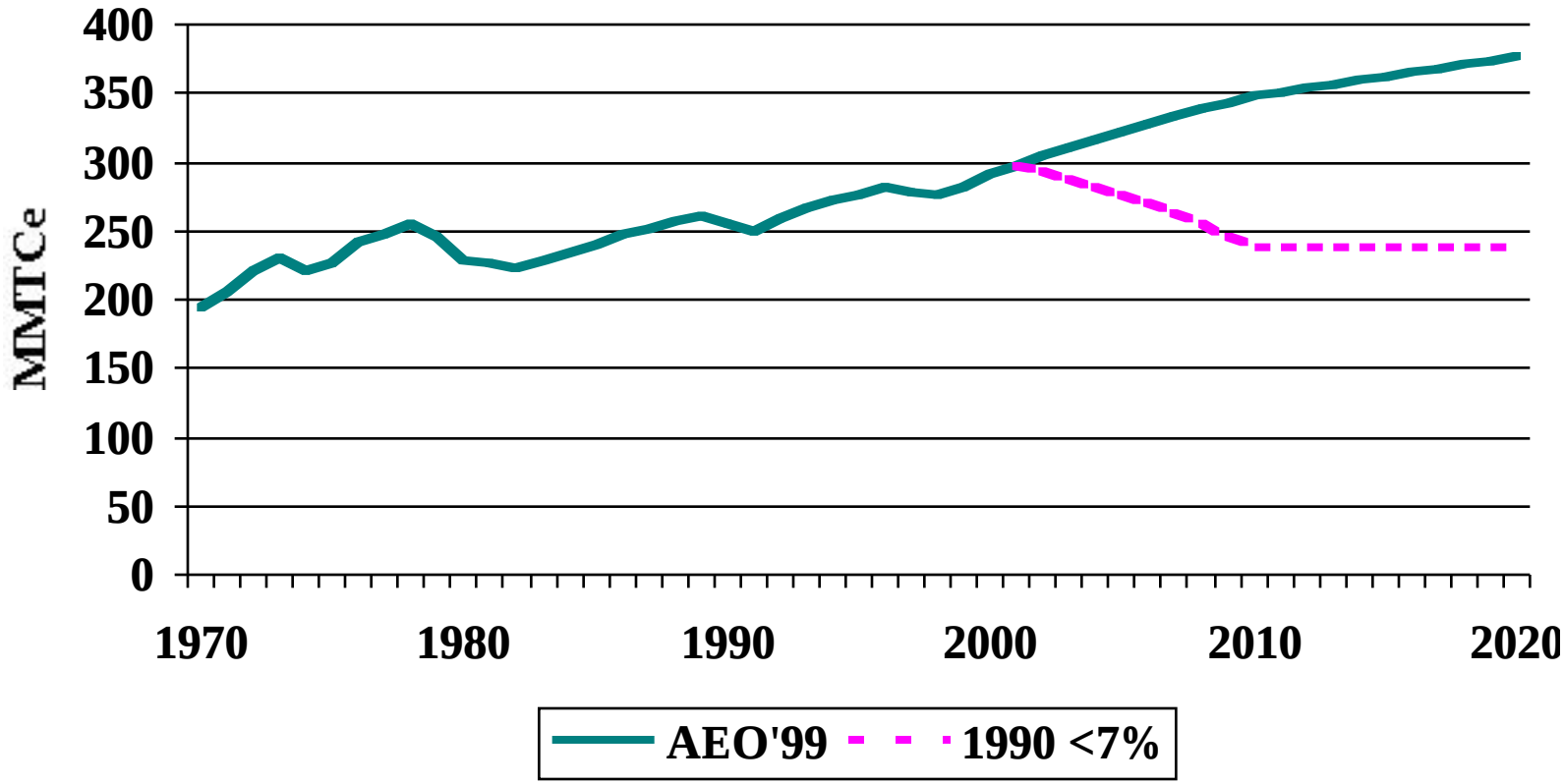
1995 Population and Vehicles per Capita

	Population (millions)	Vehicles/Capita
World	5,740	0.11
United States	264	0.76
China	1,220	0.01
Brazil	159	0.10
India	929	.01

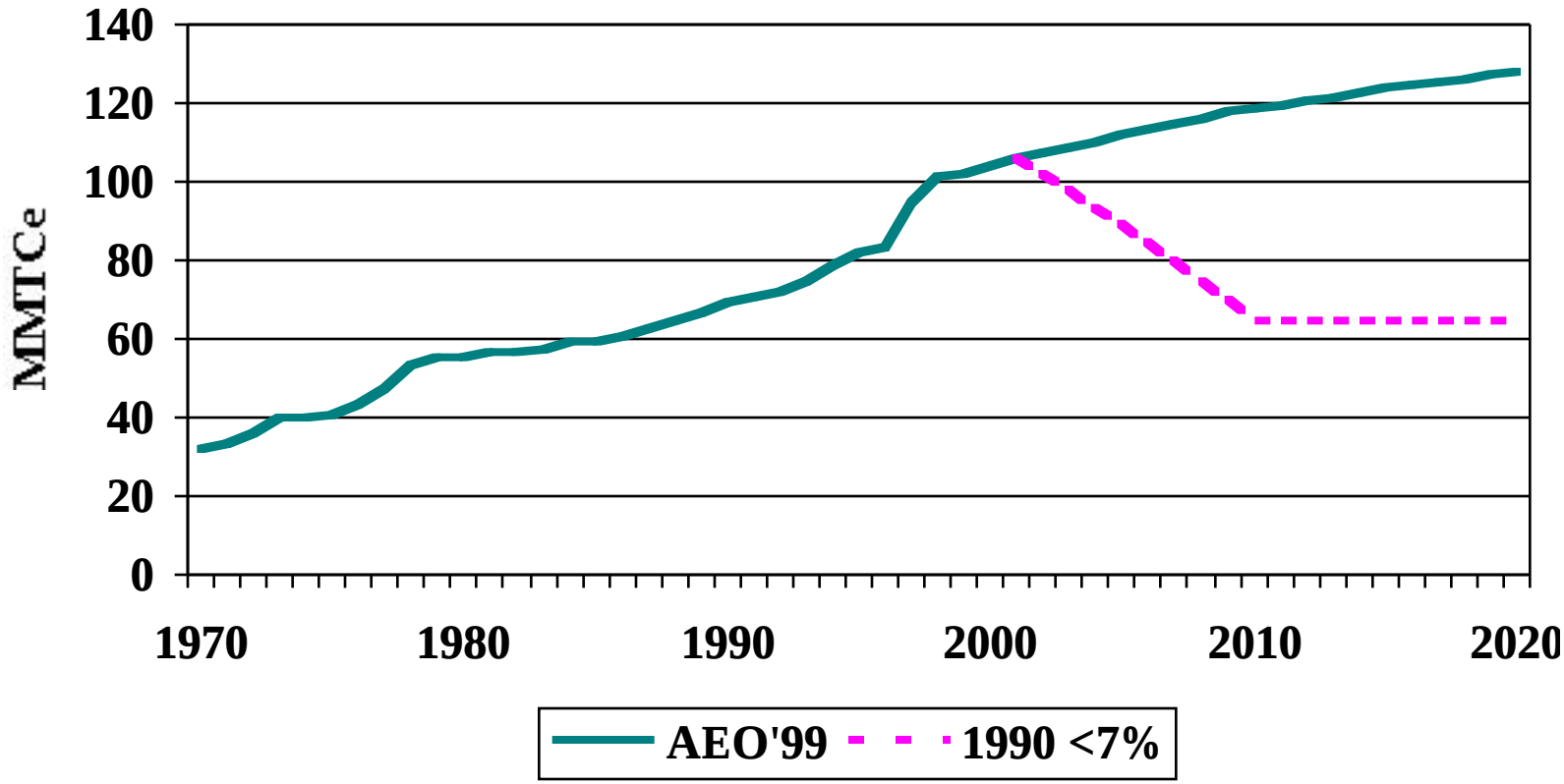
2020 Population and Vehicles per Capita

	Population (millions)	Vehicles/Capita
World	7,750	0.14
United States	324	0.80
China	1,449	0.05
Brazil	209	0.23
India	1,272	0.02

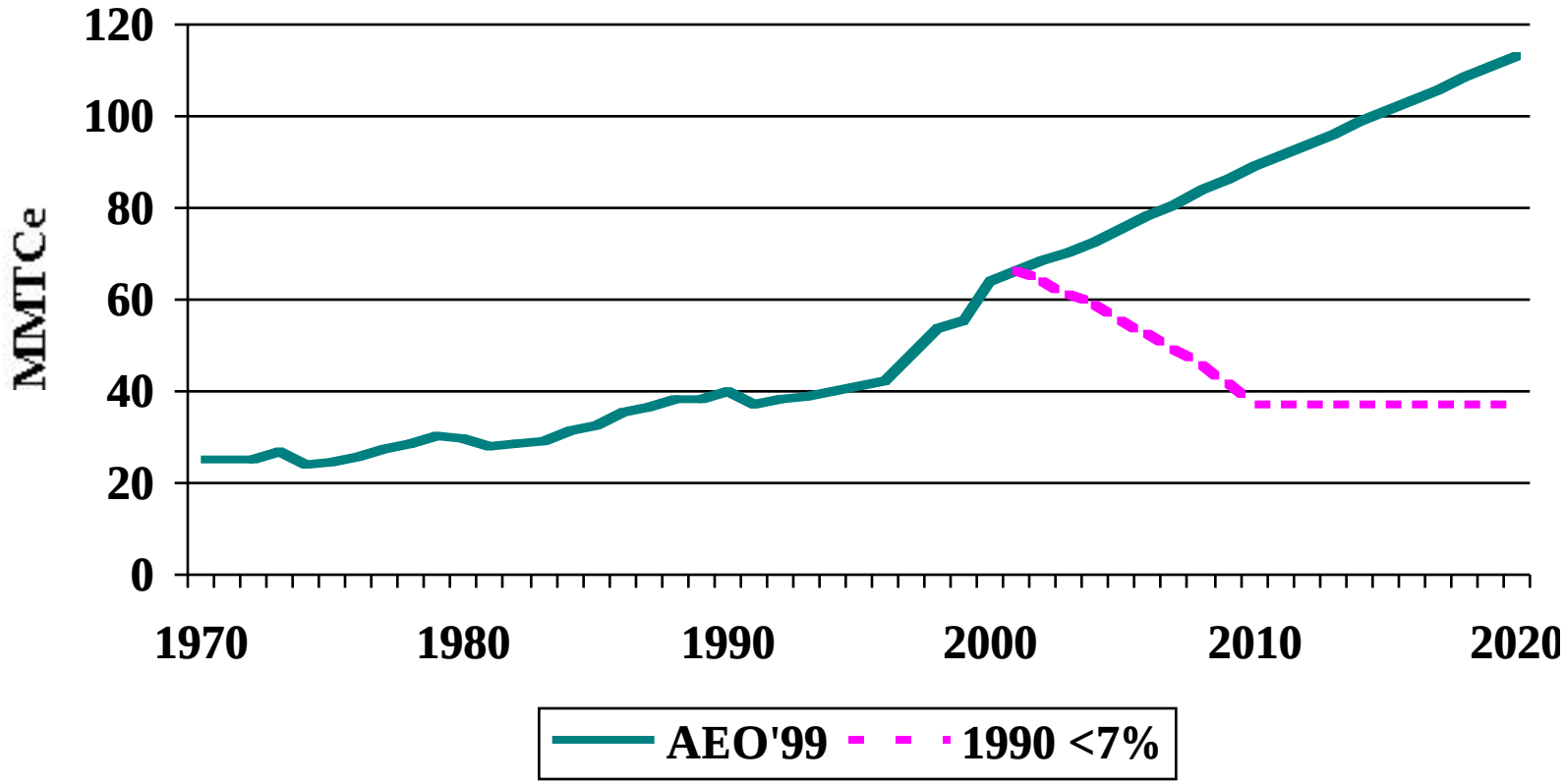
Light Vehicle Carbon Emissions Projections and Goals



Heavy Vehicle Carbon Emissions Projections and Goals



Air Travel Carbon Emissions Projections and Goals

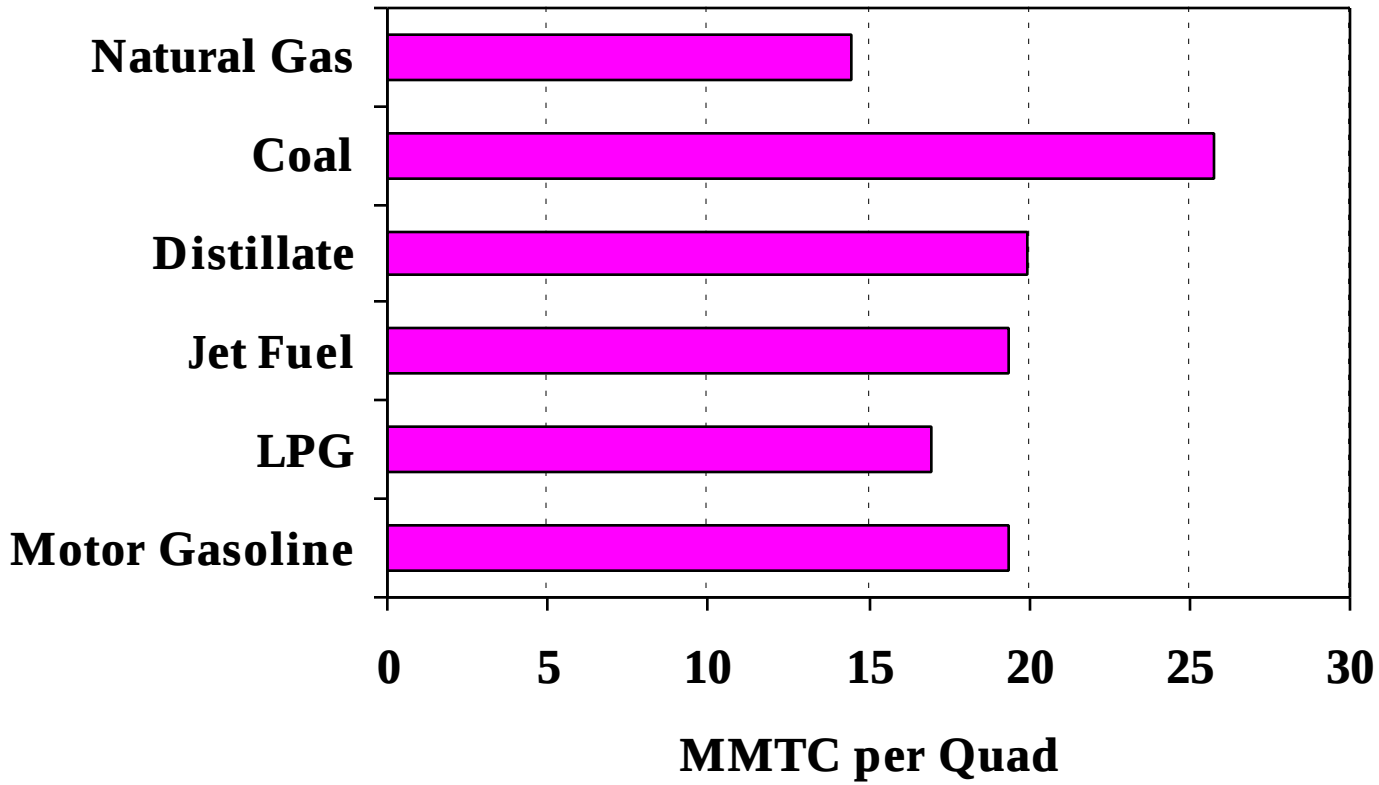


Carbon Emissions Coefficients at Full Combustion (MMTC per Quad)

- Petroleum
  - » Motor Gasoline — 19.35 MMTC per quad
  - » LPG — 16.99 MMTC per quad
  - » Jet Fuel — 19.33 MMTC per quad
  - » Distillate — 19.95 MMTC per quad
- Coal — 25.74 MMTC per quad
- Natural Gas — 14.47 MMTC per quad

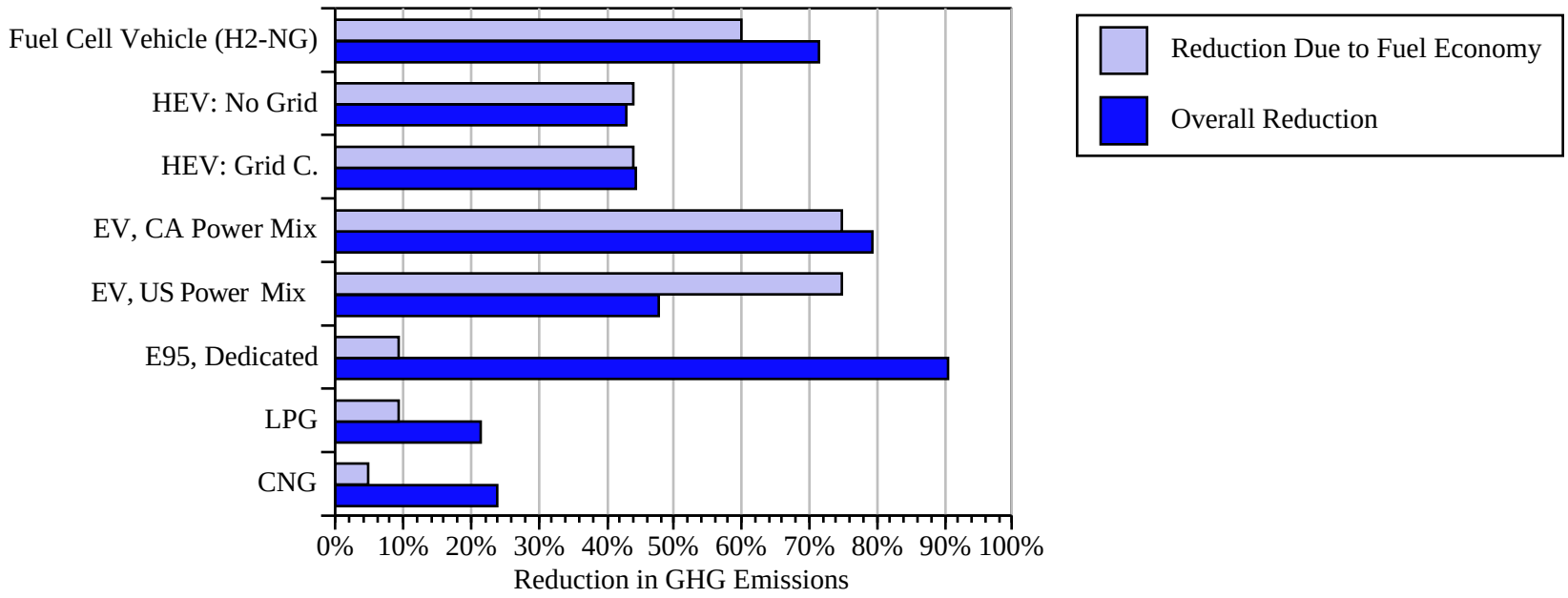
Source: EIA, “Emissions of Greenhouse Gases in the United States: 1997,” DOE/EIA-0573(97), November 1998.

Carbon Emissions Coefficients at Full Combustion (MMTC per Quad)



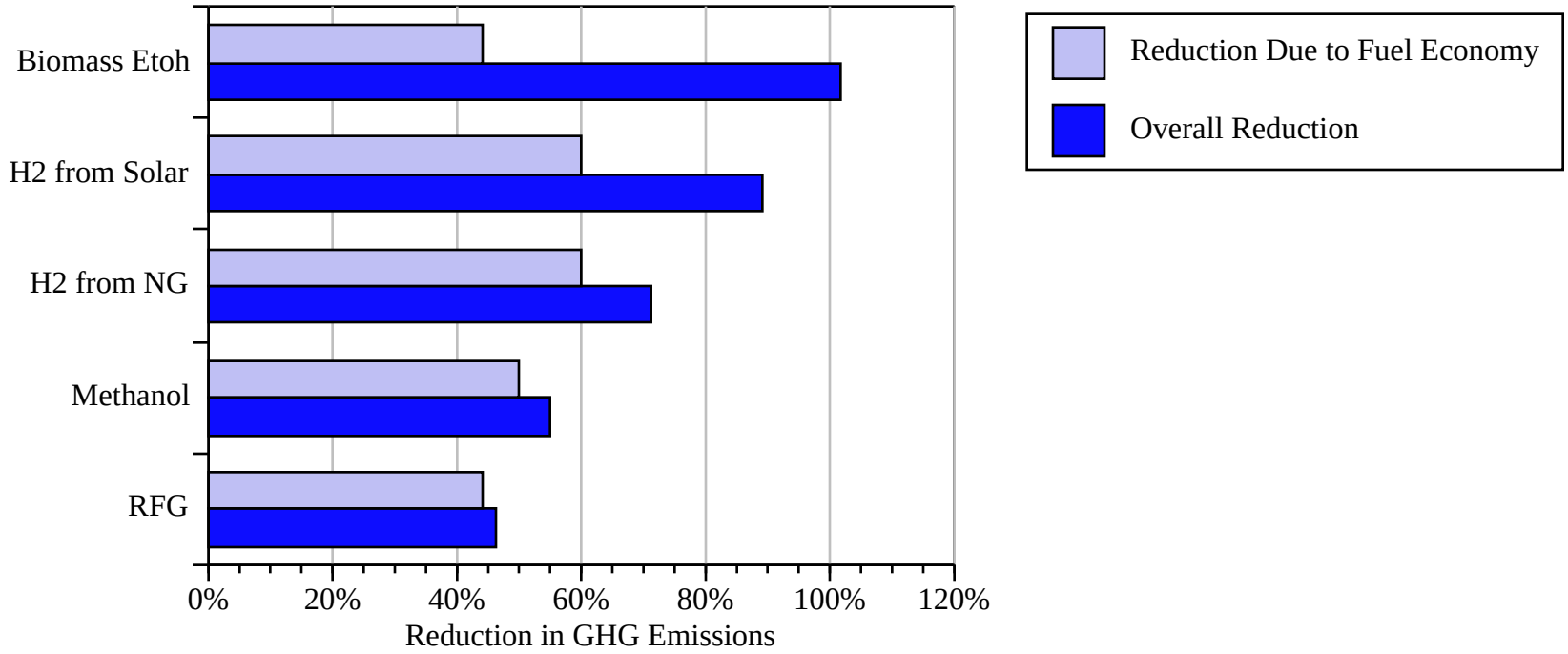
Source: EIA, "Emissions of Greenhouse Gases in the United States: 1997," DOE/EIA-0573(97), November 1998.

The Contribution of Alternative Fuels to Reducing Greenhouse Gas Emissions, 2010



Source: Personal communication with Michael Wang on results from the GREET 1.4 model, November 30, 1998.

How Fuel Affects the Fuel Economy and Reduction in Greenhouse Gas Emission in a Fuel Cell Vehicle, 2010



Source: Personal communication with Michael Wang on results from the GREET 1.4 model, November 30, 1998.

OTT's Use of GREET Model

- EE-30: EV friendly model, papers, presentations
- EE-31: Corn ethanol analysis
- EE-32: "Assessment of PNGV Fuels Infrastructure"
- EE-33: GREET heavy truck component
- EE-34:
  - Working with EPA to have it used to estimate SIP credits
  - Response to Senate request
  - Used as basis for projections on rulemaking
  - Results shared with environmental groups

If we need a 50 MMTC reduction for light vehicles from fuel economy improvements, it makes a big difference if the reduction has to be done by 2010 or can wait until 2020

New Vehicle Fuel Economy Needed to Reach a 50 MMTC Reduction

MPG in the Final Year (start in 2002)	Cars	Light Trucks
2010	47.4	31.5
2020	36.6	25.6

Year 2000 Baseline MPG: Cars = 28.2 mpg; light trucks = 20.9 mpg

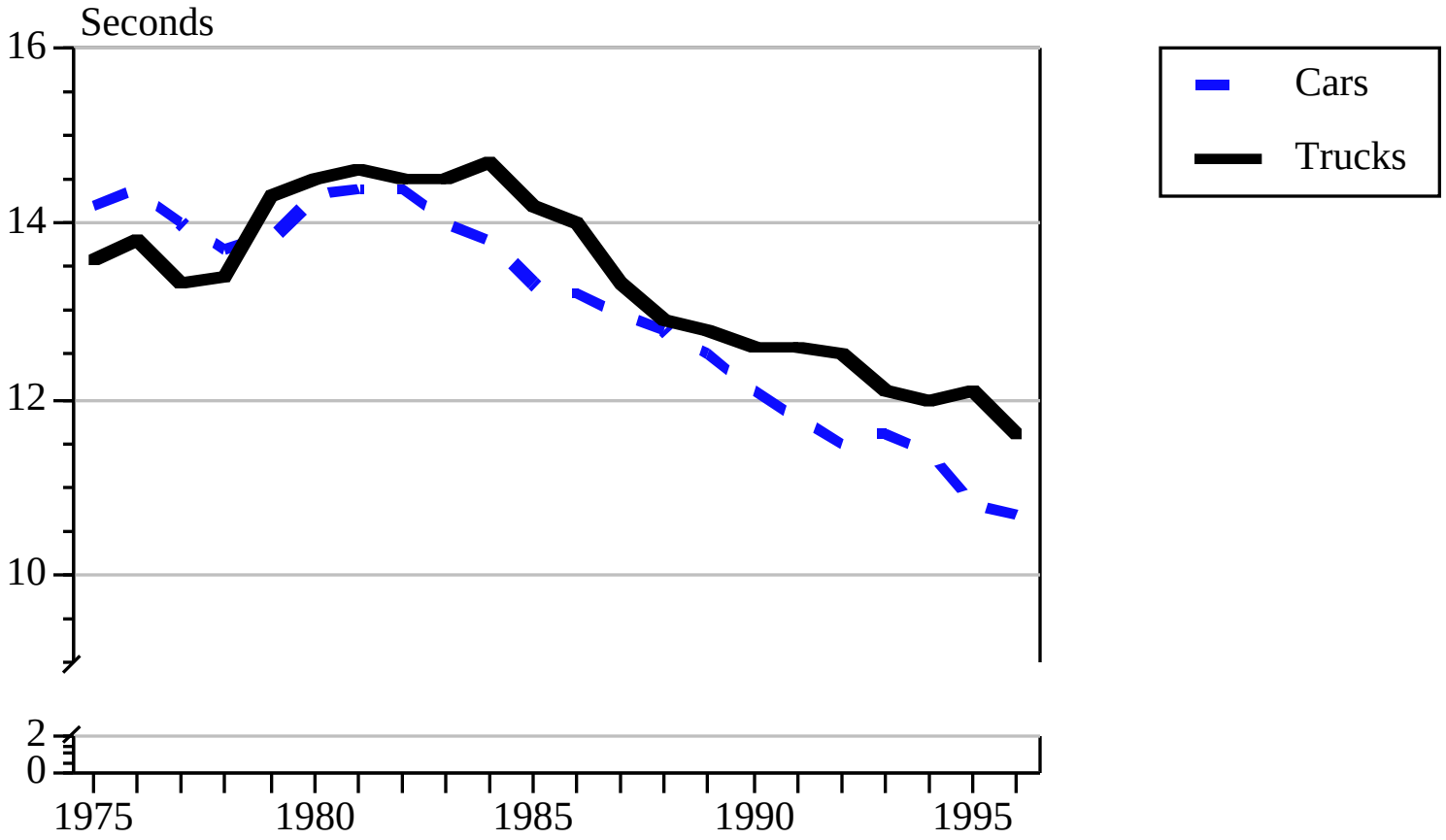
If we need a 50 MMTC reduction for light vehicles in 2010 from fuel economy gains, it makes a big difference how soon we begin improving fuel economy

New Vehicle Fuel Economy Needed in 2010 to Reach a 50 MMTC Reduction by 2010

Year Start	Cars	Light Trucks
2000	44.8	30.1
2001	45.8	30.7
2002	47.4	31.5
2003	49.8	32.9
2004	54.9	35.7
2005	74.5	46.6

Year 2000 Baseline MPG: Cars = 28.2 mpg; light trucks = 20.9 mpg

Historical Car and Light Truck Acceleration Times



Scatter Diagram of 0-60 Times v. HP / Weight

ANL Table of Top 20 Vehicle Sales in 1998

HEVs Have Higher Relative MPG at Lower 0-60 Times

The Lower 0-60 Adds to Vehicle Costs

K.G. Duleep Visit to Audi and Renault on HEVs

- Three HEV designs include two types of 4WD
  - » Engine driving front wheels, motor driving rear
  - » Engine/motor driving all four wheels
- Both are building GRID-HEVs
  - » Partially aimed at California ZEV credits
  - » Charging at home is attractive in Europe (diesel/electricity price ratio is twice that of US)
  - » Aiming for 20 to 30 miles ZEV range
- Both are working on CVT drivetrains
- See the potential delta cost for Prius type HEV to be about $600 less than $2200 estimated by Toyota

Added ZEV Range for HEVs Adds to Vehicle Cost

Opinion Research Questions, Feb. 25, 1999 (1009 Respondents)

- 16% have never purchased a new vehicle (39% for incomes under $15,000)
- Percent buying a pickup: 24% of males, 12% of females
- Will drive more because of current low gasoline prices: 13% (21% for SUV owners); average additional miles driven = 3535 miles
- Place fuel economy guide has been seen:
  - 16% in showroom
  - 2% on internet
  - 6% elsewhere

Place found information on fuel economy, if fuel economy was an important issue in last vehicle purchase

- 56% of respondents said fuel economy was an important issue in last vehicle purchase. Place found information on fuel economy:
  - 22% Window sticker
  - 12% Dealer Brochure
  - 11% Magazines
  - 5% Word of mouth
  - 4% On internet
  - 2% Television
  - 1% Fuel Economy Guide

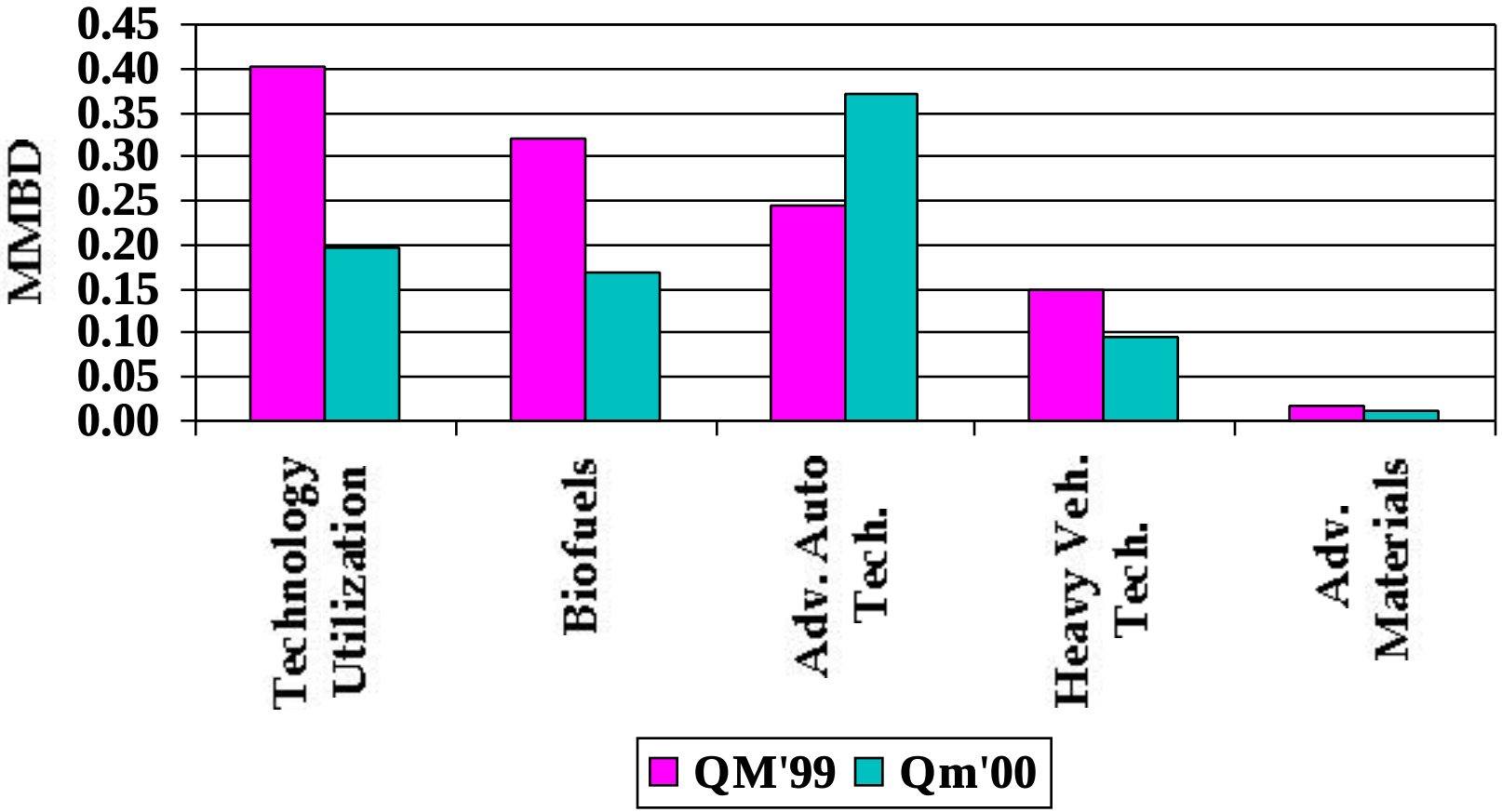
Level of interest in having more information about the environmental impacts of cars and trucks

23% (26% SUV)	5 Very interested
14%	4
25%	3
9%	2
27%	1 Not interested

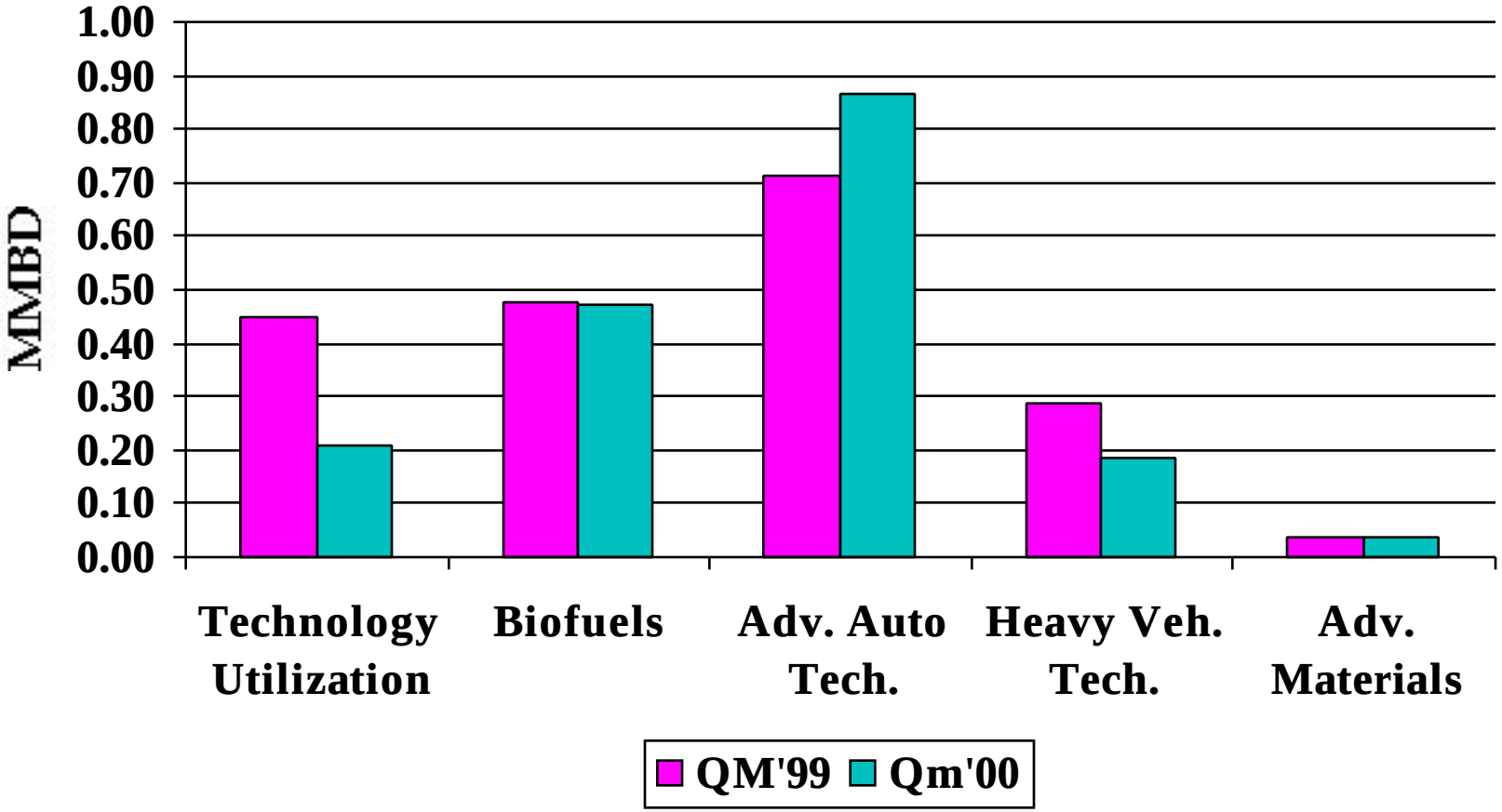
Single most important reason why bought this type of car

- Small Car
  - Price/value: 18%
  - Fuel economy: 12%
- Large Car
  - Price/value: 14%
  - Safety: 8%
- Minivan
  - Size of family: 24%
  - More space/room: 16%
  - Larger vehicle: 7%
  - Utility vehicle: 3%
- SUV
  - 4WD: 20%
  - Haul things: 5%
  - Towing: 5%
  - Bad weather: 3%
- Pickup/Large Van
  - Price/value: 10%
  - For work/business: 9%
  - Haul things: 8%
  - Utility vehicle: 4%
  - Towing: 2%

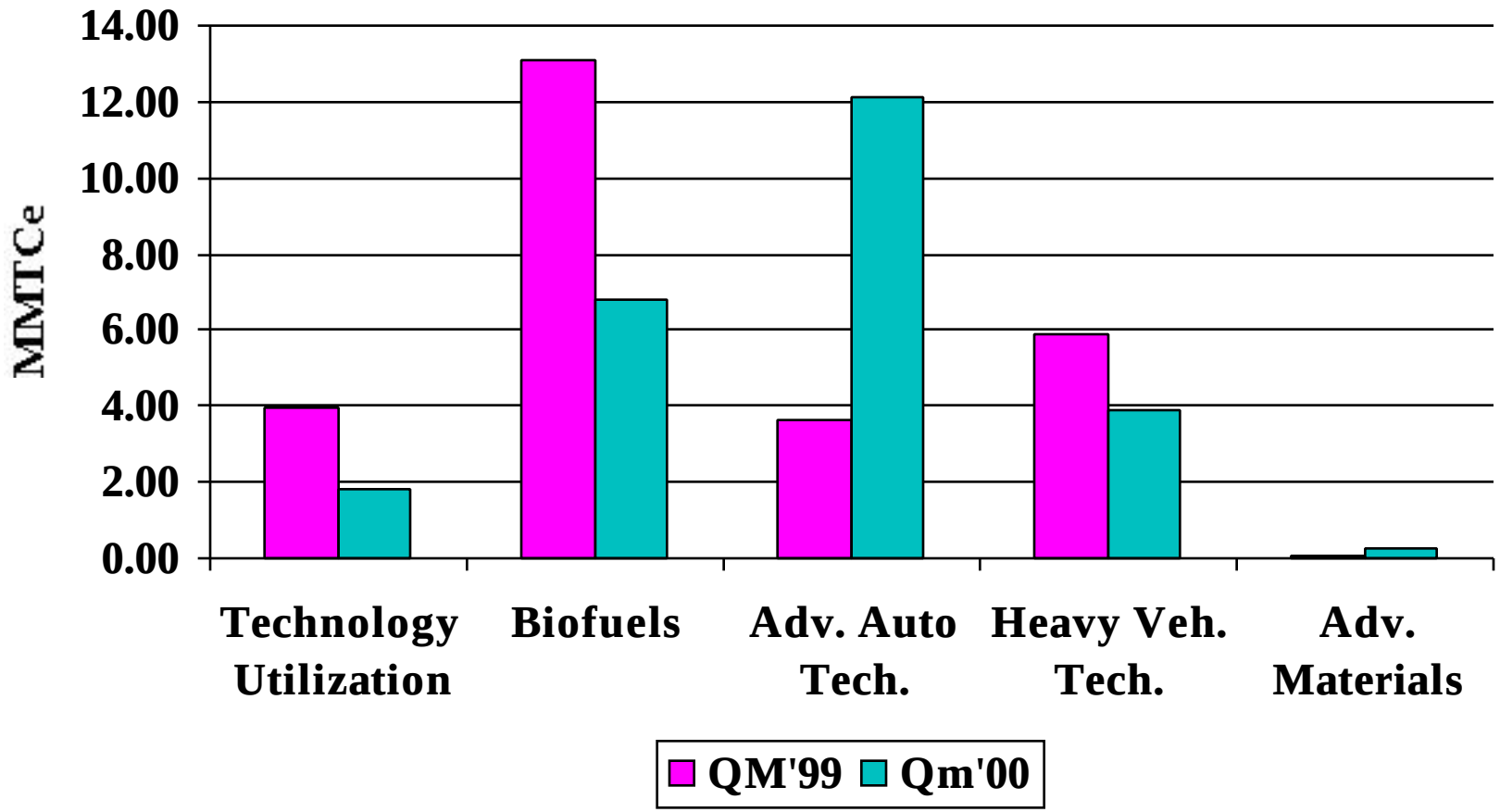
2010 Primary Oil Displaced
QM'99 / QM'00



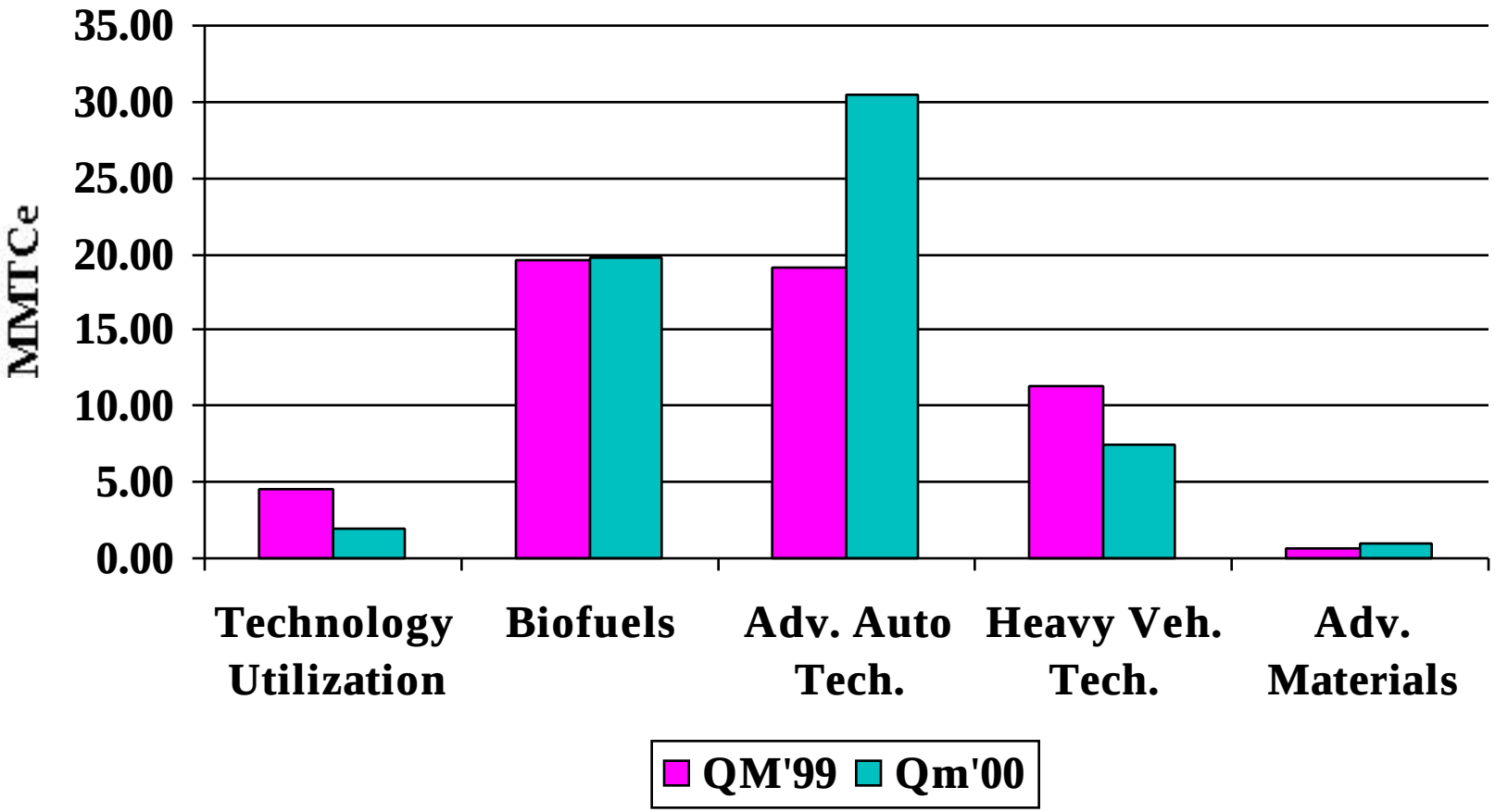
2020 Primary Oil Displaced
QM'99 / QM'00



2010 Carbon Reductions
QM'99 / QM'00



2020 Carbon Reductions
QM'99 / QM'00



Turning the Corner Slide 1

Turning the Corner Slide 2

A Suggested OTT Oil Savings Goal

"Reduce the Historical Annual Rate of Growth of Highway Oil use of 1.79% to:

	Savings (MBPD) in 2010
1.7%	0.17
1.6%	0.32
1.5%	0.48
1.4%	0.625
1.3%	.77

Suggestions for the Fuels Database

Recent “Fact of the Week”: Light Truck Sales Share